Comparison of Prospective and Retrospective Memory and Attention in Patients with Chronic Low Back Pain with Healthy People

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ABSTRACT

Objective: The present study aimed to compare prospective and retrospective memory impairment and attention deficit in people suffering from chronic low back pain with those cognitive functions in healthy subjects. Furthermore, this study examines the relation between severity and duration of pain and prospective and retrospective memory impairment and attention deficit.

Methods: The research was a causality-comparative study. Using convenience sampling method, 53 male patients and 53 healthy male individuals were selected. The participants were asked to fill out prospective and retrospective memory questionnaire and pain numeric rating scale (NRS). In addition, a continuous performance test was performed. The study hypotheses were tested using two independent group T-test and the Pearson correlation analysis by SPSS 22 with the significant level of 0.05.

Results: The results showed that there was significant difference between the 2 groups of participants regarding prospective memory, but no significant difference regarding retrospective memory. With respect to hypotheses, significant difference was found between the two groups regarding attention. And finally results of the study did not show any relation between duration and intensity of pain with impairment in prospective and retrospective memory and attention.

Conclusion: The prospective memory impairment and attention deficits are associated with chronic low back pain. In general, chronic pain is associated with cognitive impairment.

1. Introduction

There has been a great change in people's beliefs about pain and its effects over the past centuries in different cultures. Soldiers in the Middle ages considered pain as a scandal and a female trait. Religious people, however, considered pain as a sign of bless or punishment from heaven. The pain the Christ sustained was the centerpiece of beliefs of religious groups until the 13th century. However, there was a third group who believed that pain must be cured and gradually considered a serious issue in life and recognized as a disease.

Pain is the most common mental pressure known in medicine. It is a personal experience, which is described as a symptom of agony. It was not until the last century that scientists found pain as a complicated and multi-aspect phenomenon. Today, pain is known as a phenomenon sub-

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ject to environmental, mental, and social factors. It influences quality of life, and thereby, exploring its effects on mental and physical health has become part of national health and treatment systems. The Western countries recommend adding pain as the fifth vital sign along with other vital signs that need to be measured and recorded.

The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described by the patient in terms of such damage" (http://www.iasp-pain.org/Taxonomy).

The IASP defines chronic pain as "pain which has persisted beyond normal tissue healing time" (http://www.iasp-pain.org/Taxonomy).

Chronic low back pain is a common pain that decreases quality of life of millions all around the world. As documents show, human has suffered from low back pain throughout the history. Pain is a challenging problem in developed and developing countries and causes considerable economic costs.

Several studies have shown that chronic pain is correlated with cognitive functions (Berryman et al., 2013; Oostermann, Derksen, Wijck, Kessles, & Veldhuijen, 2012; Karp et al., 2006). These studies have shown a correlation between operational functions and chronic pain. Operational functions refer to a set of mental activities that are controlled by frontal lobe and are responsible for abilities such as time and attention management, attention switch, setting plan and organizing, remembering details, limiting behaviors, and using previous experiences for current tasks. When these functions face with problems, the individual loses parts of his or her ability to control his or her behavior.

These studies have found evidence of cognitive and operational functions impairment in people suffering from chronic pain. "The widely-used concept of cognition consists of many cognitive processes such as perception, memory, control, and attention. In particular, attention is a set of mechanisms that help regulate and control the search process inherent in perception and cognition" (Mohammadkhani, Eskandari, Mehrabi, Bagheri, 2015). Memory and attention deficits and problems in decision-making are some of issues that these patients have to deal with (Berryman et al., 2013). Several studies have focused on memory performance (functional and operational) among patients with chronic pain. The present study investigates the status of prospective and retrospective memory impairment (amnesia) and attention deficit on daily life of patients with chronic pains.

Memory is the way of storing previous experiences and information and using them for doing current activities. Memory is the process that has to do with dynamic mechanisms of storing, keeping, and retrieving information and experiences (Strenberg, 2006). "Memory has prominence for all aspects of information processing and that is the reason why it is invaluable to have a good memory during middle ages and late adulthood" (Ensafi, Rostami, Dolatshahi, Poursharifi, & Nouri, 2014).

With respect to storing the past subjects or future purposes, goals, or plans, memory is categorized into two types: Retrospective memory and prospective memory. Retrospective memory usually deals with what we have already known, and might be featured with wide information background. On the other hand, prospective memory focuses, for instance, on the place that something is going to carried out, and it is featured with small background information. In addition, it has to do with plans or goals that are formed to carry our daily activities. Also, retrospective memory uses several external signs (reminders), while prospective memory is based on mental goals and objectives (Eysenk & Keen, 2010).

Attention is the ability to select specific information needed to make an in-depth survey and neglect the rest. It is one of the higher mental activities. Attention is the process of focusing on specific aspects of the environment, thoughts, and activities. Focusing on specific aspects helps us to neglect irrelevant aspects of information.

Attention is the center and core of many cognitive processes and influences our perception, memory, speaking, and problem solving capabilities (Strenberg, 2006). There are some subdivisions for attention; in this study we perused sustained attention and shifting attention.

Sustained attention refers to the ability to maintain a behavioral or cognitive set in the distracting or competing stimuli (Khalili, Dolatshahi, Farhodi, Pourshahbaz, & Niknam, 2013). Shifting attention is the same as the expression of mental flexibility in operational functions (Sohlberg & Mateer, 2001).

Studies based on functional magnetic resonance imaging (fMRI) have shown that chronic pain causes morphologic changes in the brain and different types of pain create differences with specific patterns (Apkarian, Baliki, & Geha, 2009). There is some evidence that substantiated chronic pain alters dynamics of the brain by

changing the format of DMN (default mode network) in the brain (Baliki, Geha, Apkarian, & Chialvo, 2008). Furthermore, chronic pain is accompanied by rewarding system impairment in the brain (Baliki, Geha, Fields, & Apkarian, 2010). Therefore, brain morphological changes happen during chronic pain. In this regard, some changes in the density of gray matter was reported in several studies (Apkarian et al., 2004; Wilcke, Leinisch, Gaunsbauer, Draganski, & Bogdahn, 2006; Kuchinad, Schweinhardt, Seminowicz, Wood, & Chizh, 2007).

Most studies were focused on the effect of chronic pain on one aspect of cognitive functions, such as attention, executive function, or memory. The present study investigates the effect of chronic pain on two aspects of cognitive functions; memory and attention, which might be useful for investigating the anatomical effect of chronic pain on the brain in future studies. Moreover the present study examined the effect of chronic pain on 2 aspects of memory: prospective and retrospective memory. Prospective memory is important as its defect may impair treatment procedure; for instance, taking medicine at the proper time. Thus, considering this aspect of memory in treatment of patients with chronic pain may lead to better prognosis. In sum, the present study focuses on that the following questions:

Does chronic low back pain cause cognitive malfunction to the extent that its effect on daily life of patient appears as amnesia in doing planned activities and intentions?

Does chronic low back pain causes considerable prospective and retrospective memory impairment and attention deficit?

Are severity of pain and its duration related to attention deficit and memory impairment?

2. Methods

The research was carried out as a causality-comparative (ex-post facto) study in the summer 2014. Study population comprised all male patients with chronic low back pain (N=63) referred to physiotherapy and rehabilitation clinics in Tehran, Iran during a 2-month period and healthy males that accompanied them. Another part of the study population was the male workers of Darou Pakhsh Co. Tehran, Iran (as continuation of the healthy group). Totally 106 subjects (53 in patient group and 53 in healthy group) were selected through convenience sampling method, according to the inclusion/exclusion criteria. Based on Morgan table, a number of 53 patients were sufficient for patient group; in the same way, 53 healthy people were selected as healthy group. Inclusion criteria for both groups were as follows: 1) Being 40 to 50 year's old male; 2) Having a minimum of 5 years education to be able to read and understand the questions. In addition, subjects in the patient group should have a history of at least 6 months of low back pain. It must be a physical pain which was associated with actual or potential tissue damage, not a mental or psychological pain according to the physiatrist's diagnosis.

Exclusion criteria for the subjects in the patient group were as follows: 1) Low back pain due to any other source (but actual or potential tissue damage), like depression, malingering, or pain disorder; 2) Any current or past history of opiate abuse. Exclusion criteria for subjects in the healthy group were as follows: 1) Any current or past history of any continuous pain for at least 6 months; 2) Any current or past history of opiate abuse.

All subjects were informed that their personal information would be kept confidential and just the results of the study would be published. They accepted the study terms and signed the consent form. The study protocol was approved by Ethics Committee of Karaj Azad University, Karaj, Iran.

The scale is a 10-point ruler marked from 0 to 10, where 10 denotes the most severe pain. There was only one question: "Which number in the image can express your pain's severity?" The patient was asked to highlight one figure on the scale. Reliability and validity of the scale have been confirmed.

Ara-Munos, De Leon, Feinstein, Puente, and Wells (2004) compared 3 pain scales of numeric scale, verbal scale, and visual scale with a standard pain stimulator. Correlation coefficients of numeric scale, visual scale, and verbal scale were obtained as 0.735, 0.818, and 0.796, respectively; external Kappa weighted means were obtained as 0.59, 0.7, and 0.65, respectively; and internal weighted mean was obtained as 0.48, 0.61, and 0.54, respectively. Boonstra, Preuper, Reneman, Posthumus, and Stewart (2008) estimated validity and reliability ranges of the numeric rating scale (NRS) as 0.76-0.84 and 0.6-0.77, respectively. Mohammadkhani Shahri, Abbaspoor, Aghel, Mohammadkhani Shahri, (2012) found reliability of NRS with two replications as 0.91. The scale has been used in several Iranian and foreign studies.

This questionnaire was designed by Smith, Della Sala, Logie, and Maylor (2000). It consists of 16 questions designed based on 5-point Likert-scale (1=always, 2=mostly, 3=sometimes, 4=rarely, and 5=never; max

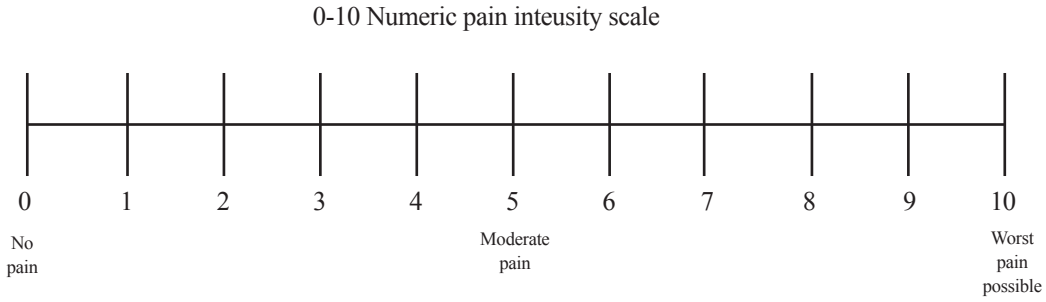

Figure 1. Pain severity numeric rating scale.

point=40, min point=8). The scale has 2 main subscales: retrospective and prospective memory each with 8 questions. Crawford, Maylor, Della Sala, and Logie (2003) tested prospective retrospective memory questionnaire (PRQM) using a large study group of 551 members aged 17-94 years. The Cronbach α for retrospective, prospective and the whole questionnaire was obtained as 0.80, 0.84, and 0.89, respectively. The Farsi version of PRQM has been normalized by several studies. Zare and Mostafaie (2014) used a group of 382 participants and obtained the Cronbach α as 0.38.

Continuous performance test (CPT) is a test to measure attention, which was designed in 1956 by Rosvold, Mirsky, Sarason, Bransome, and Beck (1956). The Farsi version of CPT was prepared by Hadianfar, Najarian, Shekarshekan, and Mehrabizadehonarmand (2001). It is featured with numerical and pictorial moving images and the subjects should select the moving target while the software measures reaction time, reaction error, and deletion errors. Scoring is based on 2 indexes of error and reaction time so that error point is the sum of wrong answers and deletion errors.

Hadianfar, Najarian, Shekarshekan, and Mehrabizadehonarmad, (2001) tested reliability and validity of CPT. Reliability of the tool was obtained with 20 days retest and the correlation coefficient was obtained at the range of 0.59–0.93, which means a high correlation. The test measures one's ability to stay focused, alert, and concentrated. The test only uses visual stimulations and when the target stimulator appears the participant should push a bottom. Each stage has 150 stimulators and 20% of them are target. Each stimulator is displayed for 200 ms with 1 s interval. Each stage takes 200 s to finish and comprised of two stages of numbers and pictures.

At number stage, 150 figures (in Farsi) are displayed and 30 of them are targets. At the end of the test, the results are generated as deletion response, wrong response, and reaction time in three 50-item groups. In addition, total mean of the deletion response, wrong response, and reaction time are computed. At image stage, 150 images are displayed so that 30 images are the target and results are generating like the first stage. Validity of the test was obtained through criterion validity using heterogeneous groups; one group of 30 normal participants and one group of 25 hyperactive children. Comparison of mean points showed significant differences at 0.001 level.

In the patient group the chronic low back pain was confirmed by a physiatrist and then demographic informa-

Table 1. Retrospective and prospective memory and attention (reaction time & errors) scores.

Variable	n	Mean	Min	Max	SD
Prospective memory (patient group)	53	29.603	23	35	3.335
Prospective memory (healthy group)	53	31.132	25	37	2.689
Retrospective memory (patient group)	53	31.471	23	37	3.111
Retrospective memory (healthy group)	53	31.924	23	38	3.954
Error point (patient group)	53	5.506	0	18	3.943
Reaction time (patient group)	53	968.754	805	1618	149.786
Error point (healthy group)	53	4.207	0	9	2.830
Reaction time (healthy group)	53	885.301	743	1007	63.414

Table 2. Kolmogorov-Smirnov test.

	Prospective memory	Retrospective memory	Error point	Reaction time
Kolmogorov-Smirnov statistics	0.085	0.079	0.086	0.084
Sig. (two tailed)	0.067	0.119	0.063	0.075

tion profile and pain history form were filled by subjects. Next, the subjects were evaluated by NRS to evaluate the severity of pain. Afterwards, they were evaluated by PRQM regarding their prospective and retrospective memory. Finally, CPT assessed their attention status.

In the healthy group participants did 3 steps. First, they completed demographic information profile, then PRQM questionnaire, and finally were evaluated by CPT software.

The findings were entered into SPSS-22 to analyze the data. Descriptive statistics were used to calculate mean, maximum, minimum and standard deviation. Independent-samples t test was used to determine effects of chronic low back pain on retrospective and prospective memory. Finally, the Pearson correlation was used to determine the correlation of pain severity and duration with retrospective and prospective memory impairment and attention deficit.

3. Results

The participants' ages ranged between 55 and 40 years. Their mean age was 45 years and there was small difference between the healthy and patient group in this regard.

As shown in Table 1, there is a significant difference between patient group and healthy group regarding prospective memory mean and reaction time mean scores.

Assessment of the normality of data was done by the Kolmogorov-Smirnov Test. The results are presented in Table 2. According to the Table 2 null hypothesis indicating normal distribution is accepted.

T-test results are presented in Table 3.As shown in Table 3, T-test results indicate that;

- There is a significant difference between healthy and patient groups regarding prospective memory (t=-2.037, Sig.=0.05),
- There is a no significant difference between healthy and patient groups regarding retrospective memory (t=-.316, Sig.=0.05),
- There is a significant difference between healthy and patient groups regarding reaction time (t=3.442, Sig=0.05),
- And also there is a no significant difference between healthy and patient groups regarding error points (t=0.438, Sig=0.426).

As shown in the Table 4, the Pearson correlation test results indicate that there is no relation between pain's severity or duration and prospective and retrospective memory impairments and attention deficits.

4. Discussion

This study aimed to examine the effects of chronic low back pain on retrospective and prospective memory and attention and also the relation between severity and duration of pain and these cognitive impairments. To this end, 5 hypotheses were raised:

Table 3. T-test results of prospective and retrospective memory and reaction time and error points of healthy and patient groups.

Element	Leven's test		T-test				
	F	Sig.	T	df	Sig.	Mean difference	SD of difference
Prospective memory	2.254	0.136	-2.037	100	0.023	-1.336	0.579
Retrospective	5.906	0.17	-0.316	100	0.753	0.210	0.664
Reaction time	7.924	0.060	3.442	100	0.001	53.575	15.566
Error points	0.638	0.426	0.438	100	0.662	0.241	0.550

Table 4. Pearson Correlation test.

Pearson Correlation test		Duration of pain	Severity of pain
Prospective memory	Pearson correlation coefficient	-0.193	-0.059
	Significant (two tailed)	0.184	0.685
Retrospective memory	Pearson correlation coefficient	-0.143	-0.188
	Significant (two tailed)	0.328	0.196
Error	Pearson correlation coefficient	0.190	0.071
	Significant (two tailed)	0.191	0.627
Reaction time	Pearson correlation coefficient	0.055	0.128
	Significant (two tailed)	0.705	0.381

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1. There is a difference between healthy individuals and patients with chronic low back pain regarding prospective memory.

2. There is a difference between healthy individuals and patients with chronic low back pain regarding retrospective memory.

3. There is a difference between healthy individuals and patients with chronic low back pain regarding reaction time and error response (attention).

4. There is a relation between severity and term of pain of patients with chronic low back pain and prospective and retrospective memory impairment.

5. There is a relation between severity and term of pain of patients with chronic low back pain and attention deficits.

The results showed that there was significant difference between the 2 groups regarding prospective memory and reaction time but there was no significant difference between the two groups regarding retrospective memory and error responses. And also our result did not show any relation between severity and duration of pain and prospective and retrospective memory impairment and attention deficit.

Our results showed that chronic pain affects prospective memory. This finding is consistent with the results of Ling, Campbell, Heffernan, and Greenough (2007). They studied the effect of chronic low back pain on prospective memory and showed that there was significant difference between healthy and patient groups. Other studies like Luoto, Taimela, Hurri, and Alaranta, (1999); Krap et al. (2006); Berryman et al. (2013); Dick and Rashik (2008) indicate that memory and executive operation impairments are caused by chronic pains. These studies show the association of chronic pain with some changes in brain such as brain networks, brain dynamic, and brain award system.

The present study showed that there was no significant difference between the two groups regarding retrospective memory. A lot of studies on the neuroanatomy of retrospective memory have shown the brains' regions that control retrospective memory; for example, Kesner (1989) study on retrospective memory, Okuda et al. (2003) study on the role of the medial temporal lobe in retrospective memory, Ferbinteanu and Shapiro (2003) study on the role of hippocampus, Cheng, Tiau, Hu, Wang, and Wang (2010) study on the role of thalamus in memory, and Phelps (2004) study on interactions of the amygdala and hippocampal complex in memory.

So we can say" important areas of memory function are hippocampus, amygdala, and frontal cortex" (Saleh, Posht Mashhadi, & Dolatshahi, 2015). Some studies showed that frontal lobe play an important role in prospective memory. In other words, accuracy in executive functions leads to accuracy in prospective memory and supervisory of executive function is done by frontal lobe (Martin et al., 2007). Supposedly, chronic pain can affect frontal lobe and harms executive functions. However, this is a hypothesis which should be examined in further studies.

Our results showed that there was significant difference between the 2 groups regarding reaction time. By reaction time, we refer to time interval between initiation of stimulation and emergence of reaction (Shams Esfandabad, 2012). Longer reaction time indicates decrease in flexibility of brain to switch from one stimulation to next one. In other words, long reaction time associates with at-

tention deficit. Oosterman, Derksen, Wijck, Kessels, and Veldhuijen (2012) showed that attention deficit, decrease in brain flexibility and psychomotor speed are related to chronic pain. The results showed that attention and reaction time subscales in patients with chronic pain are different from those of healthy individuals. Our results were also consistent with study results of Dick and Rashik (2006), and Oosterman, Derksen, Wijck, Kessels, and Veldhuijen (2012). Our result did not show any significant difference between patient and healthy group regarding the error responses and also our result did not show any relation between severity and duration of Pain with prospective and retrospective memory impairment and attention deficit which can be studied more in further studies.

Cognitive problems like memory and attention deficits associated with chronic pain may cause disorders in the individual life and also treatment procedure. Therefore, paying attention to this subject is important. It is suggested that at the pain clinics or rehabilitation clinics some cognition evaluating tests (like the ones used in this study) can be done and cognitive rehabilitation could be a part of chronic pain treatment protocol. There are some limitations in this research. For one thing, we could not separate the effect of chronic pain and calmative drugs on memory and attention, because all patients had already consumed calmative drugs. It is suggested that future studies investigate the results on both genders and various age groups, as well as to survey the relation between other kinds of chronic pain and cognitive components.

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